Biochemical composition of pelagic sargassum biomass, and effects of processing and storage on potential products

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Teleconnected SARgassum risks across the Atlantic: building capacity for TRansformational Adaptation in the Caribbean and West Africa (2019-2022)

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The University of the West Indies at Mona, Jamaica

MGI BLUE Coastal Dynamics Modelling Laboratory

CERMES

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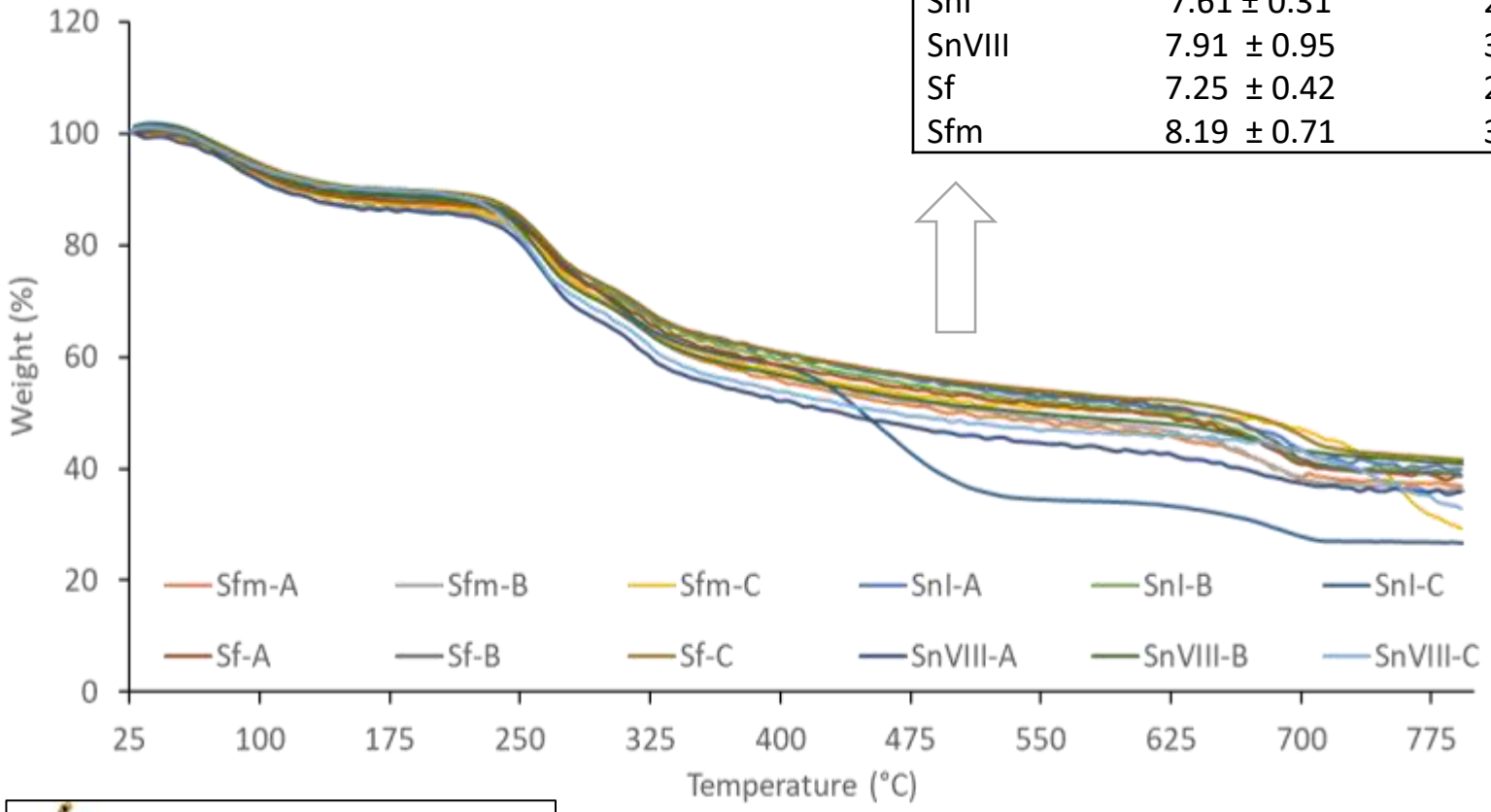
1. Composition analysis of pelagic sargassum morphotypes: Sampling in Jamaica - February 2019

⇩

- Sun-dried samples
- Comparison between morphotypes after pooling values from sites A-B-C

A quick glimpse by thermogravimetric analysis

Samples	Moisture content (weight %)	Organic matter content (weight %)	Calcium carbonate content (weight %)	Char content (weight %)
SnI	7.61 ± 0.31	29.11 ± 1.32	9.49 ± 1.75	35.16 ± 6.05
SnVIII	7.91 ± 0.95	33.73 ± 1.47	6.30 ± 0.47	36.60 ± 3.24
Sf	7.25 ± 0.42	28.86 ± 0.40	10.75 ± 1.10	39.63 ± 1.34
Sfm	8.19 ± 0.71	30.61 ± 0.75	8.56 ± 1.53	34.12 ± 3.46



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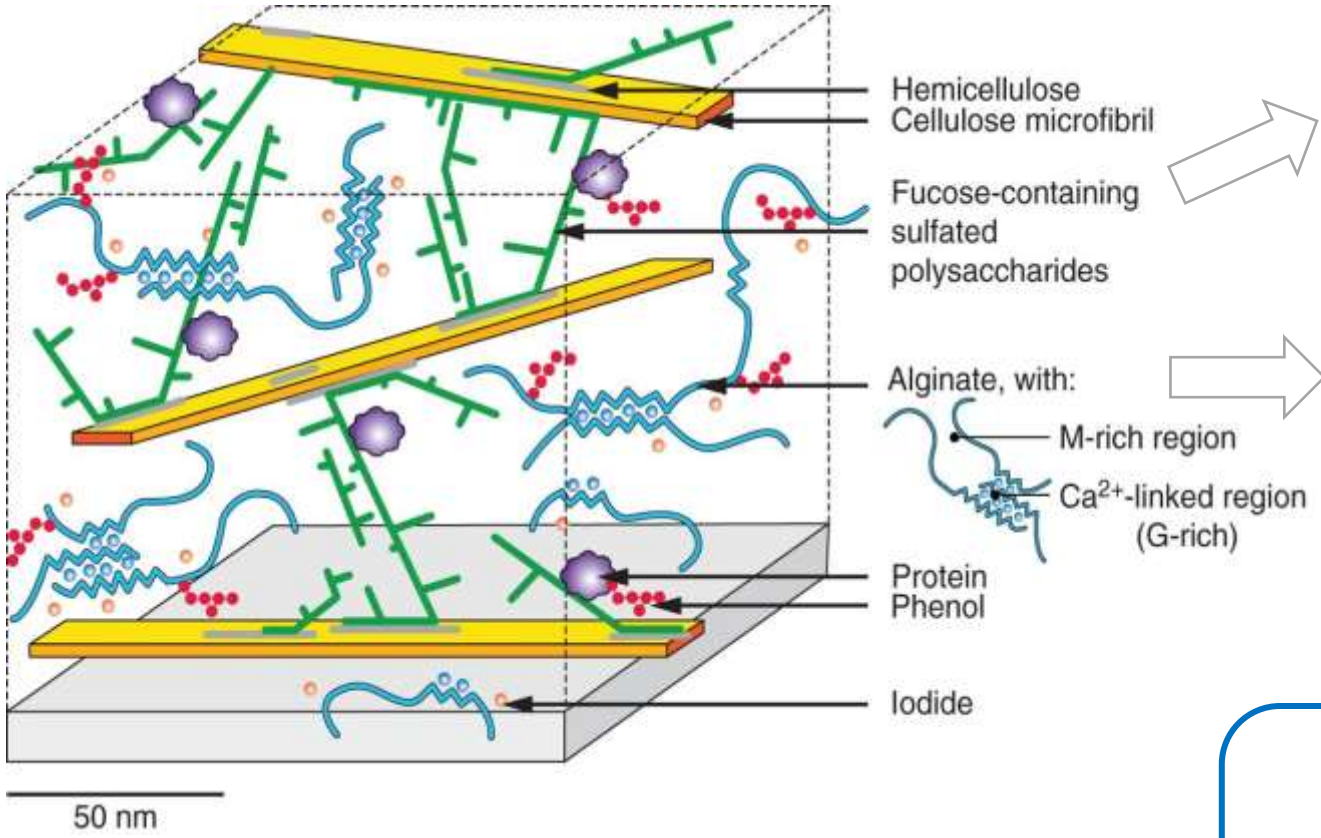
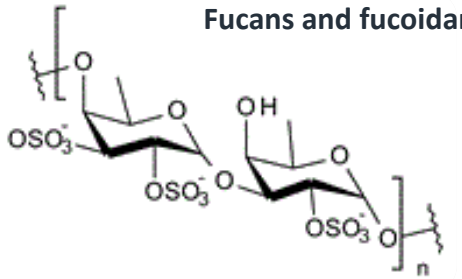
Analysis of monosaccharide composition

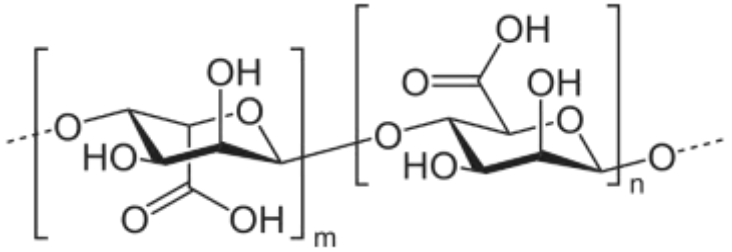
- **Cell wall model for brown algae**



Fucans and fucoidans

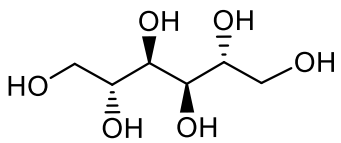


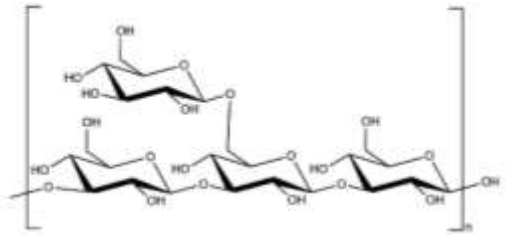
FCSPs (fucose and other sugars)



Alginate (mannuronic and guluronic acid)

- **Carbon storage**

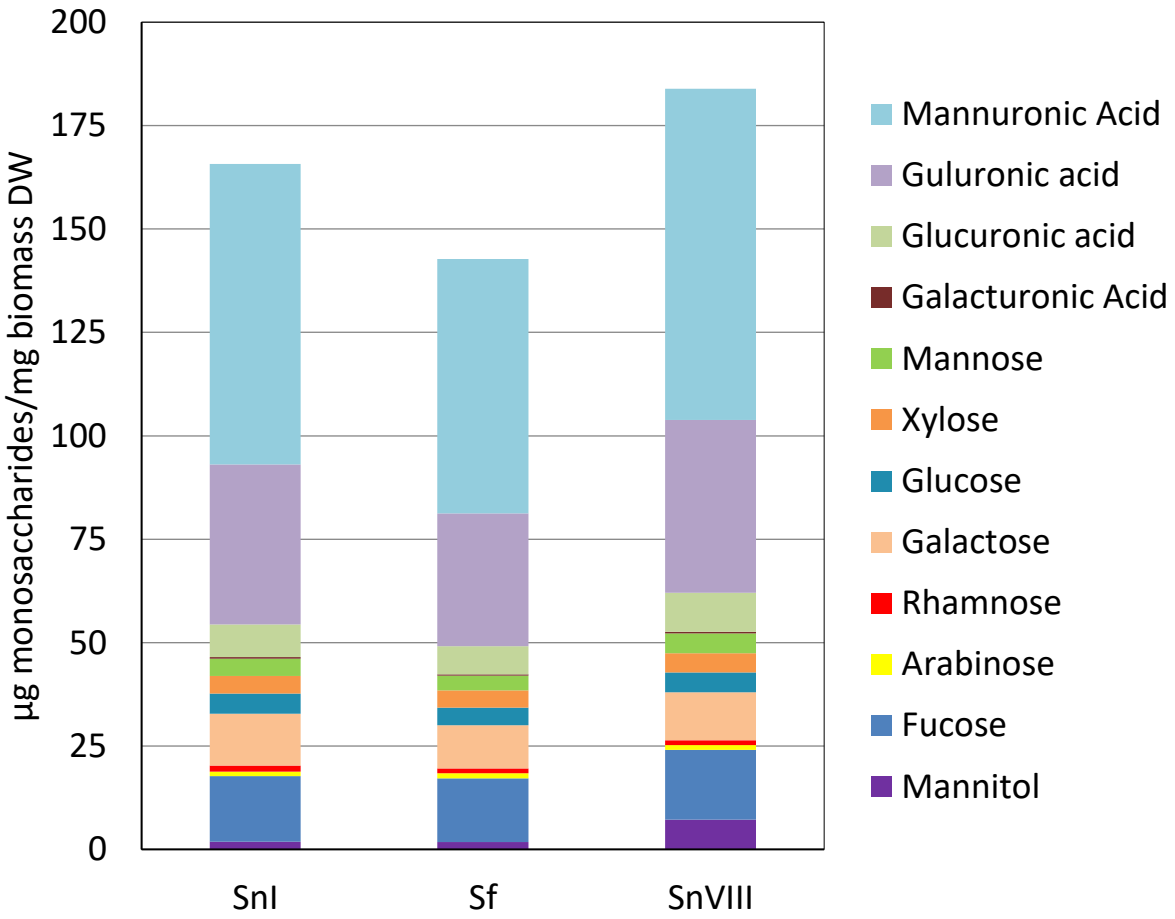




Mannitol and laminaran (glucose and mannitol)

Analysis of monosaccharide composition

- **Total content**: significantly different only between SnVIII and Sf.
- Most abundant: **mannuronic and guluronic acids** (**alginate**). Focus in next slide.
- **Mannitol**: four times more abundant in SnVIII compared to other morphotypes (less than 1% biomass DW).
- **Fucose** (**FCSPs**) and **mannose**: significant difference between Sf and SnVIII.
- **Galactose, glucose, xylose, rhamnose** and **arabinose**: no significant difference between morphotypes.



- Trifluoroacetic acid hydrolysis
- HPAEC + amperometry detection

Alginate content and composition

Samples	Alginate (% dry weight)	Alginate (% total monosaccharides)	M (% alginate)	G (% alginate)	M/G ratio
SnI	11.13 ± 2.02	66.85 ± 2.45	65.05 ± 1.47	34.95 ± 1.47	1.87 ± 0.12
SnVIII	12.18 ± 2.10	66.09 ± 2.59	65.86 ± 3.58	34.14 ± 3.58	1.97 ± 0.39
Sf	9.36 ± 2.51	65.15 ± 4.83	65.49 ± 3.80	34.51 ± 3.80	1.94 ± 0.42

- Alginate content and M/G ratio: no significant differences between the three morphotypes.
- Alginate = 9 – 12 % of DW ⇨ Lower range compared to 12–45 % DW from the brown seaweeds used for industrial production of alginates.

Analysis of elemental composition (site A only)

- **Total content**: significantly lower in SnVIII compared to SnI and Sf.
- **Macroelements**: significant variations for Na, Mg, and Ca between SnVIII vs. SnI and vs. Sf.
- **Microelements**: significant variations for Fe and Mn among the three morphotypes.
- **Metalloids**: arsenic content significantly higher in SnI compared with SnVIII and Sf.

- **Arsenic content**:

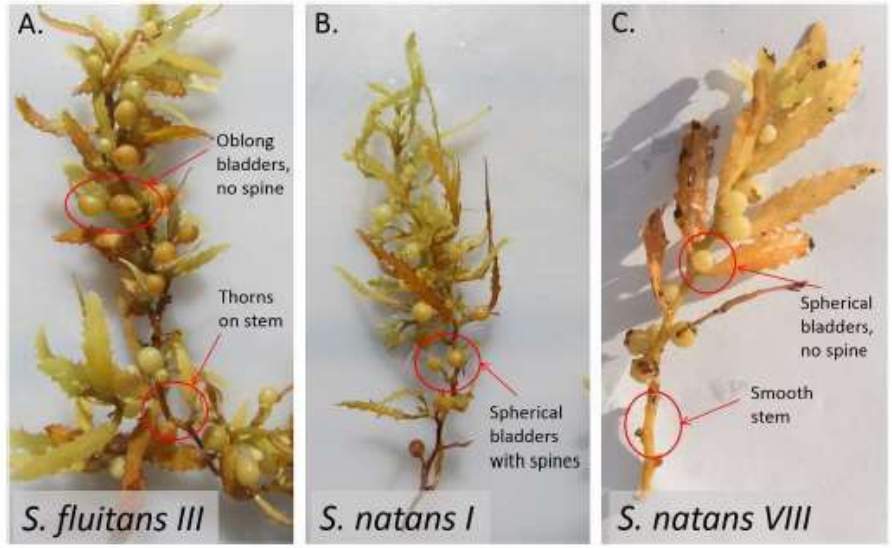
-Above the maximum level permitted for seaweed meal and feed materials derived from seaweed in Europe (40 µg/g DW).

-Exceed limits recommended for agricultural soils in different countries (15–50 µg/g DW).

Elements	SnI (µg/g DW)	SnVIII (µg/g DW)	Sf (µg/g DW)
Na	11,441.00 ± 237.24	14,436.18 ± 575.76	11,310.71 ± 406.27
Mg	8,456.26 ± 300.36	6,193.47 ± 146.48	8,684.03 ± 292.54
Al	335.69 ± 18.70	187.70 ± 31.79	427.57 ± 54.94
K	28,701.30 ± 527.46	32,865.84 ± 1003.03	30,503.78 ± 1225.51
Ca	56,138.23 ± 1864.90	36,435.64 ± 690.72	57,726.79 ± 1813.97
V	2.37 ± 0.06	2.28 ± 0.18	4.21 ± 0.43
Cr	3.18 ± 0.99	1.50 ± 0.54	9.18 ± 0.37
Mn	39.62± 0.36	13.03 ± 0.48	22.92 ± 0.66
Fe	634.79 ± 18.18	237.07 ± 44.26	832.97 ± 101.84
Co	0.91 ± 0.07	0.47 ± 0.03	0.89 ± 0.06
Ni	4.21 ± 0.16	3.87 ± 0.10	3.52 ± 0.08
Cu	4.29 ± 0.16	2.78 ± 0.14	4.47 ± 0.20
Zn	14.71 ± 1.98	6.35 ± 0.62	7.2 ± 1.20
As	64.91 ± 0.61	60.30 ± 0.34	58.32 ± 2.29
Cd	0.77 ± 0.43	0.40 ± 0.02	0.57 ±0.02
Ba	22.17 ± 0.67	19.21 ± 0.65	23.21 ± 0.42
Pb	2.47 ± 1.79	0.33 ± 0.13	1.11 ± 0.47
U	0.80 ± 0.08	0.79 ± 0.01	0.83 ± 0.04
Total	105,867.69 ± 2926.44	90,467.20 ± 2410.74	109,622.32 ± 3618.09

2. Influence of processing and storage on biochemical composition
Sampling in Jamaica - summer 2020

Mix all together ⇨ **Sun-dried samples.**



Remove all foreign material present in the seaweed biomass, i.e. plastic-mud-sand-animals-algae other than sargassum (no tap water wash).

→ 3 x 2 kg → For each 2 kg: separate the 3 morphotypes (morphotype abundance analysis)

→ 3 x 100 g → Slightly dry with some tissue/towel (to avoid freezing too much seawater), and freeze the sargassum biomass as soon as possible at -20C.
Frozen samples.

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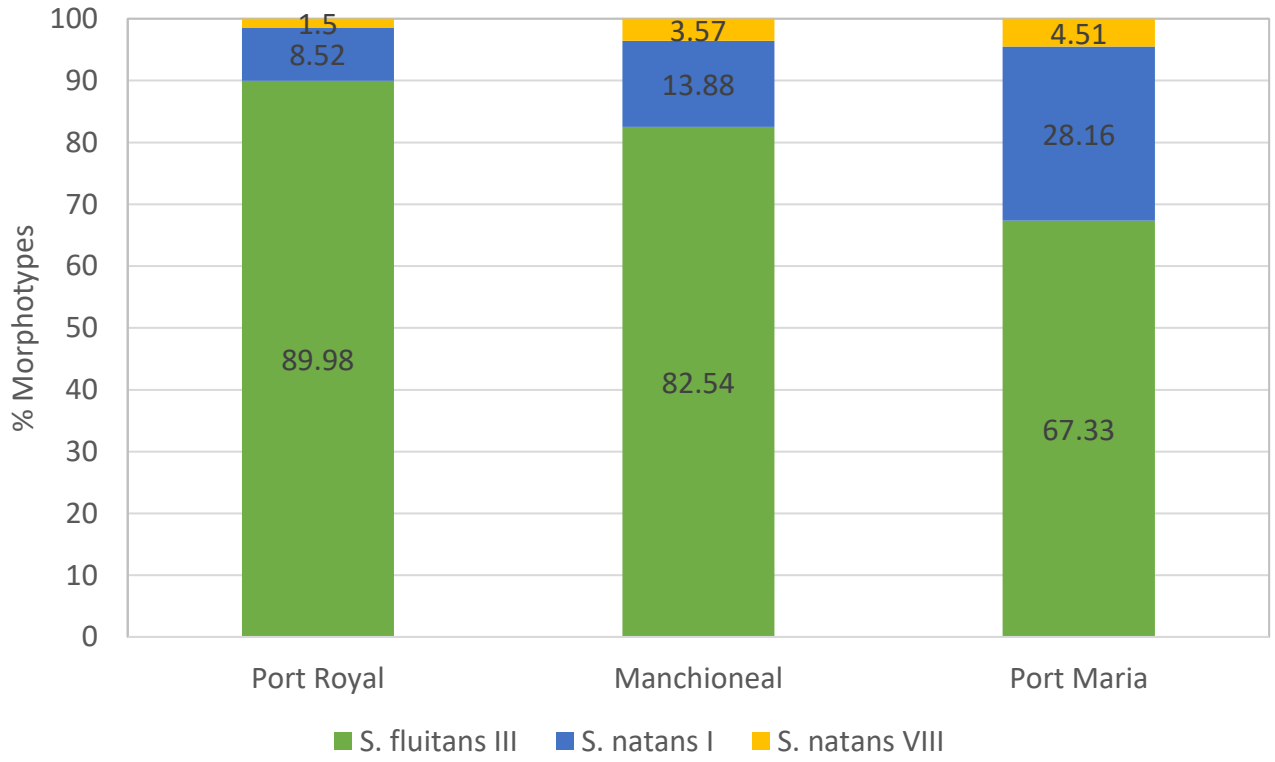
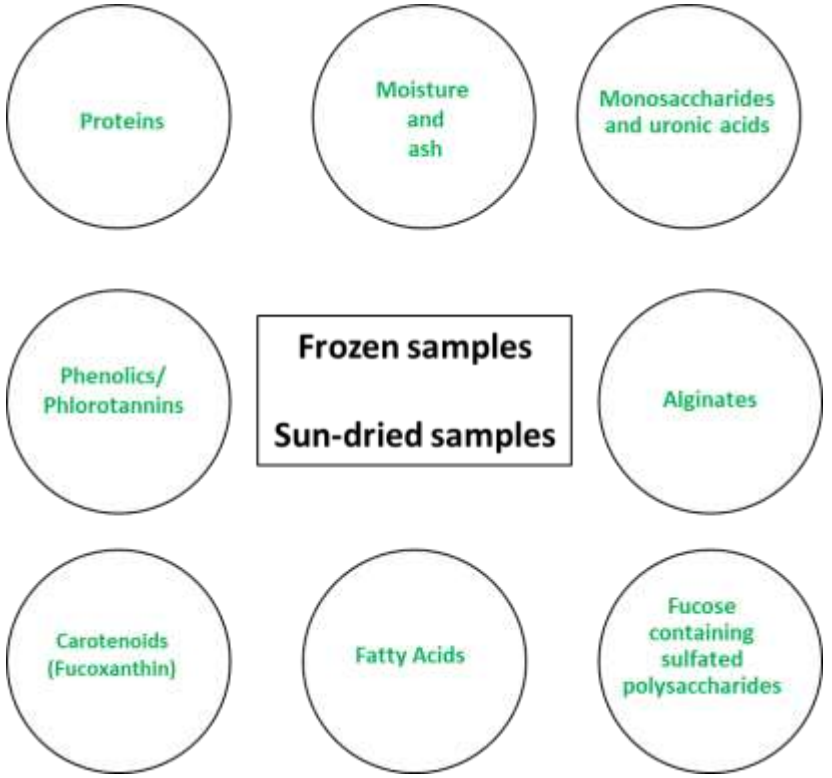
Morphotype abundance and biochemical analysis





- ***S. fluitans* III > *S. natans* I > *S. natans* VIII**

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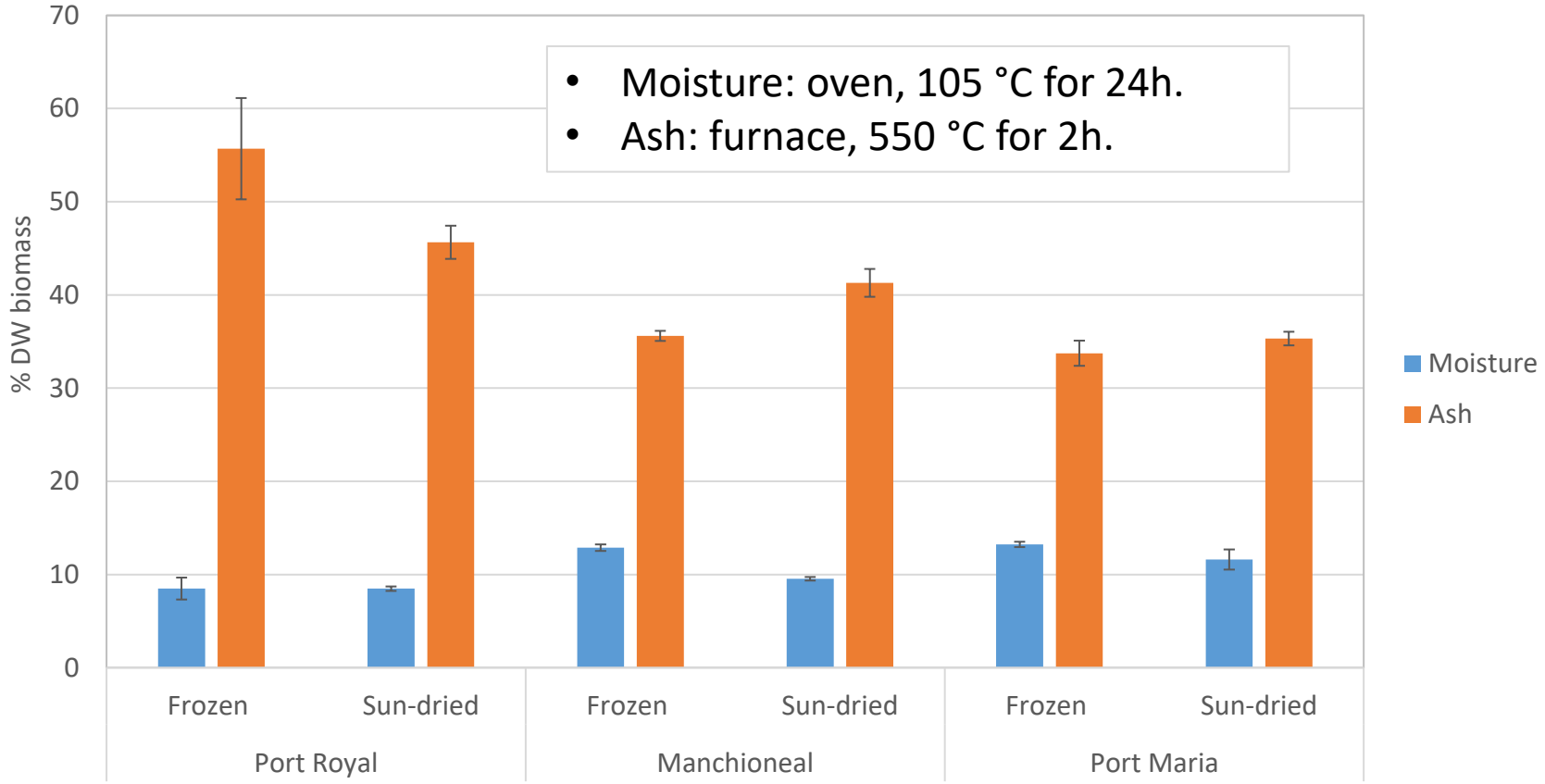
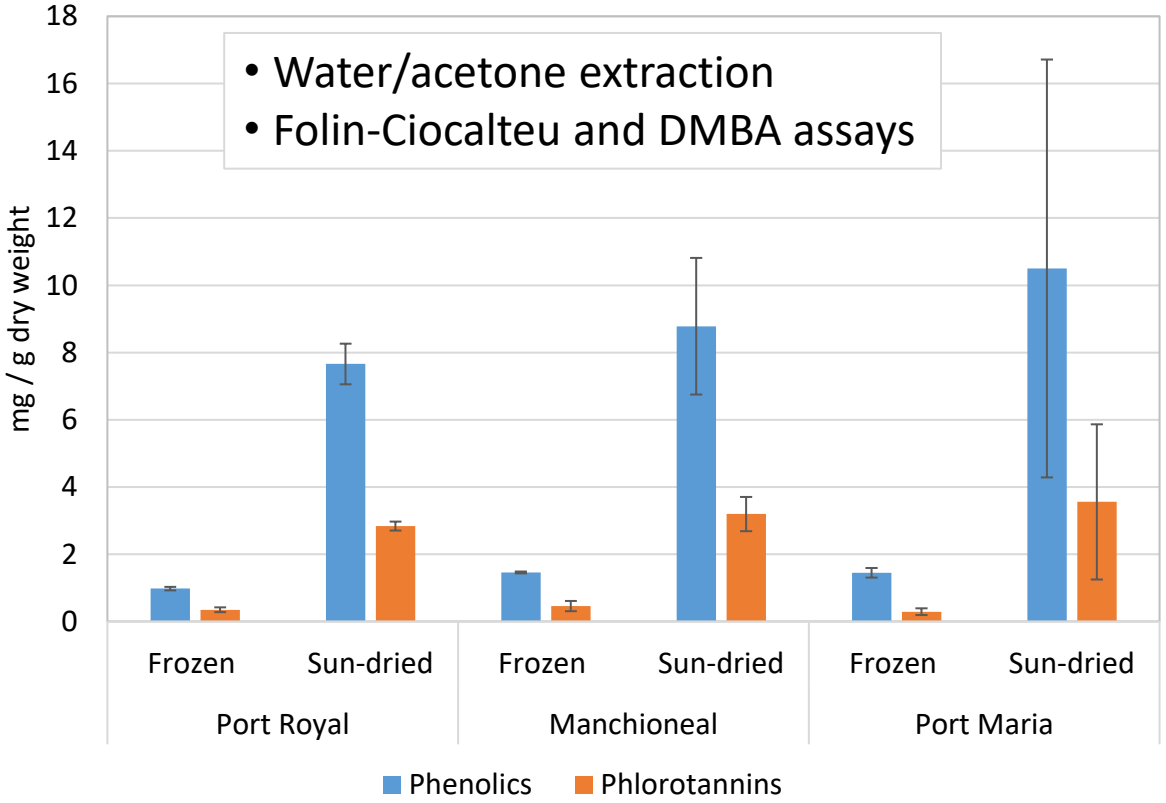
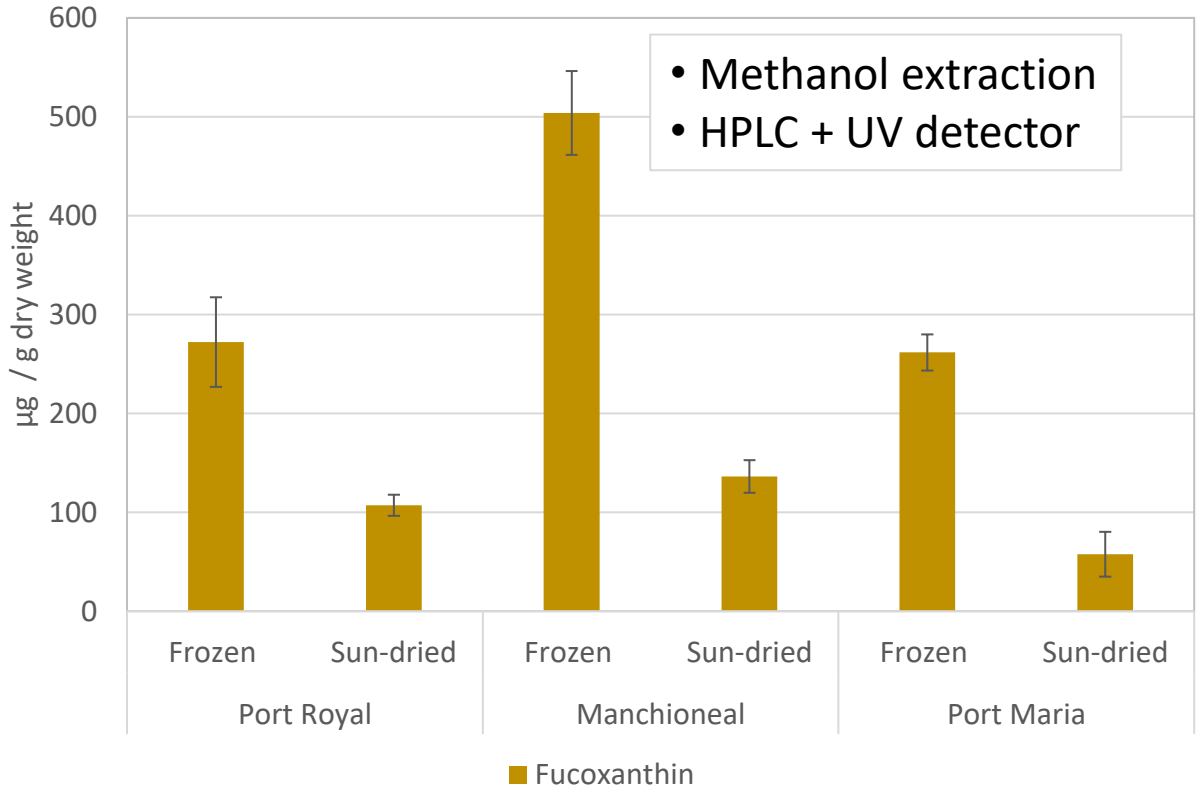
Ash (char) and moisture content



- Ash: 33.7-55.7 % of the algal dry weight (DW) in frozen samples, 35.3-45.7 % in sun-dried samples.
- Sampling sites: significant differences between frozen and sun-dried samples for Port Royal and Manchioneal.

Content of some antioxidant compounds

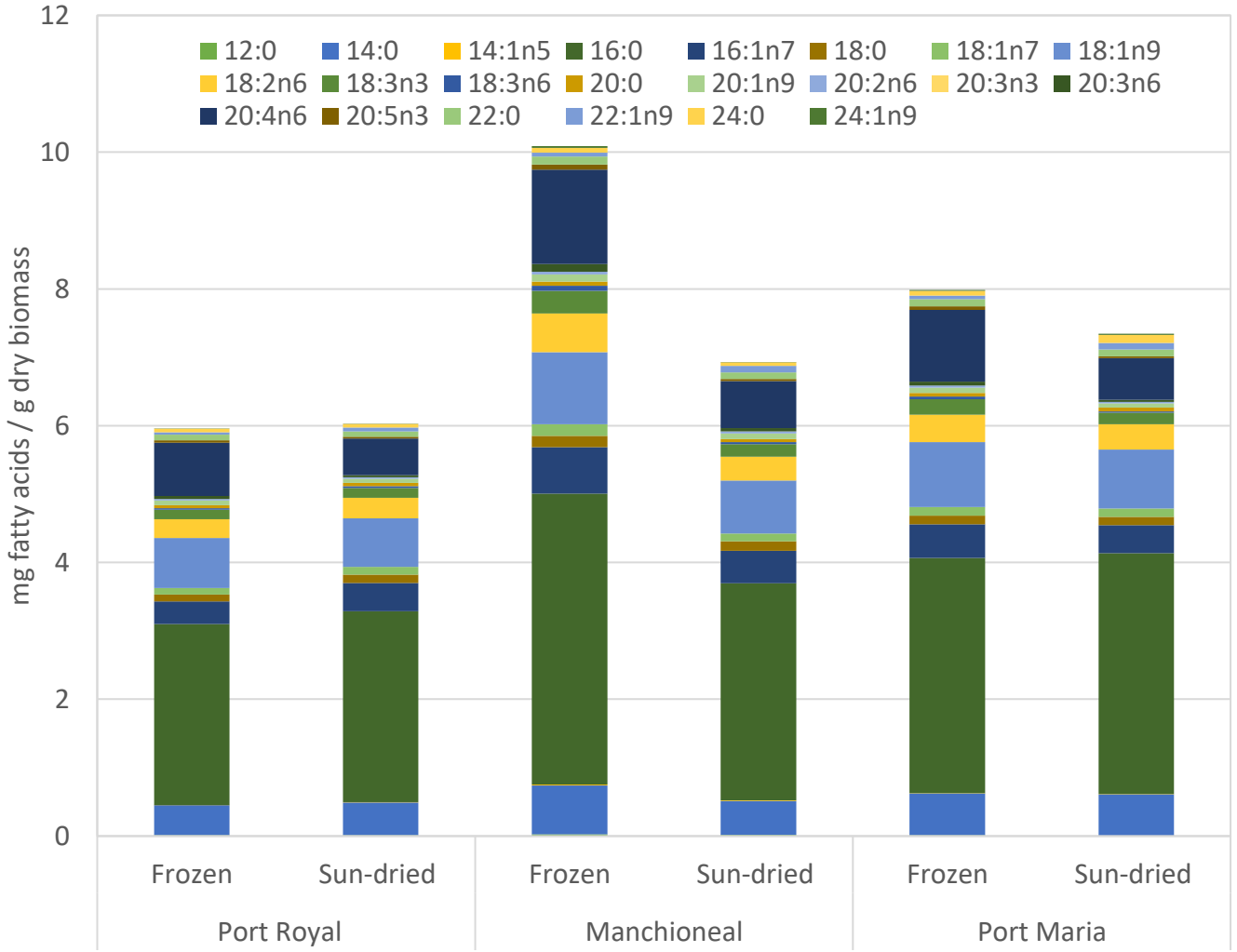




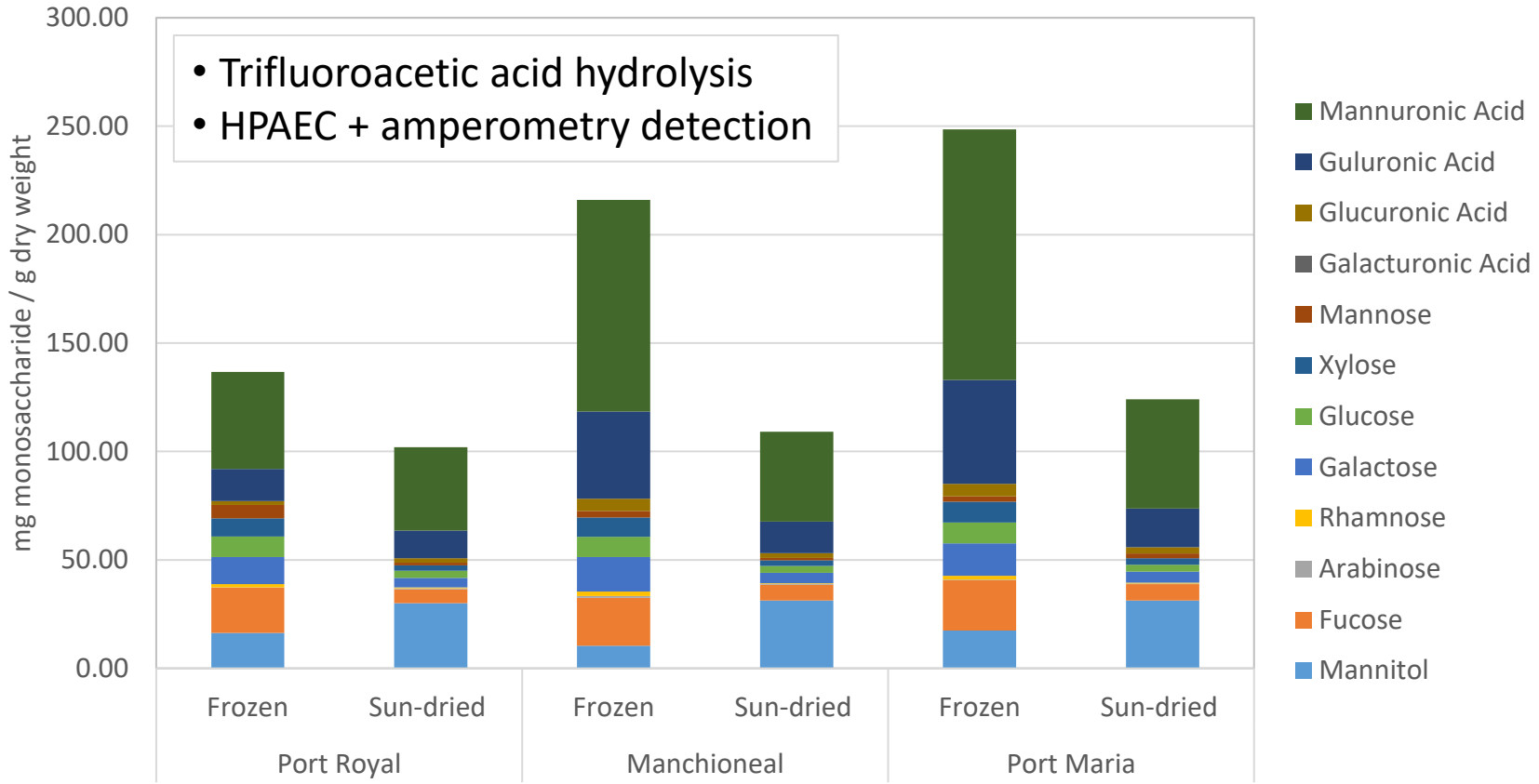
- Phenolics and phlorotannins: higher contents in sun-dried samples (up to 1 % DW).
- Fucoxanthin: higher content in frozen samples (up to 0.05 % DW).

Fatty acid content (GC-FID)

- FAs: 0.6–1% of the biomass DW.
- Higher amount in frozen compared to sun-dried samples, except for Port-royal samples.
- 16:0 (40-50 %) > 20:4n6 (8-14 %) > 18:n9 (10-12 %) > 14:0 (7-8 %).
- Limited changes in the % of individual FAs between frozen and sun-dried samples except for 20:4n6.



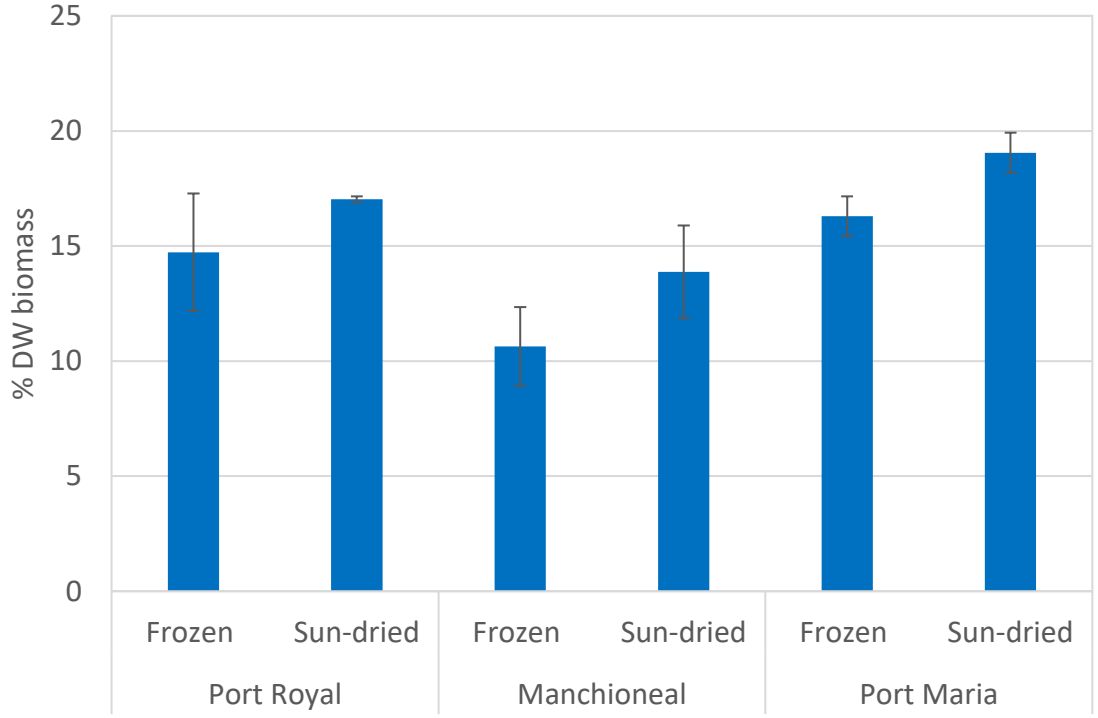
Analysis of monosaccharide composition



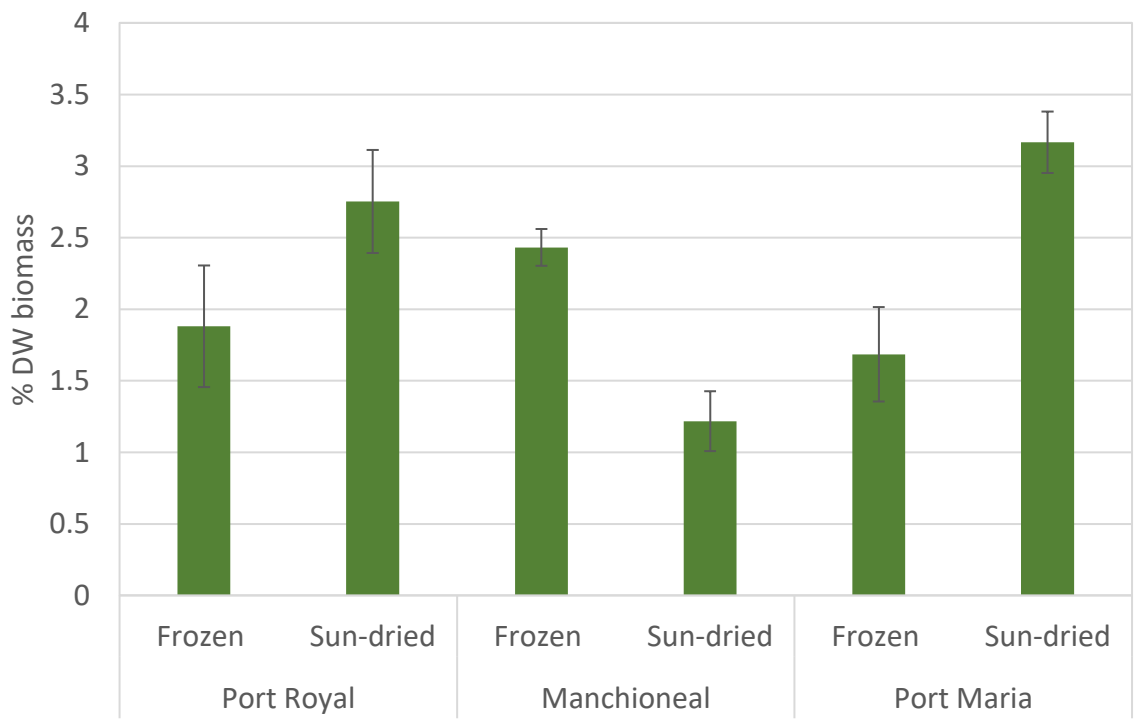
- Higher quantities of sugars in frozen compared with sun-dried samples.
- **Mannitol**: higher quantities in sun-dried samples (5-10% compared to 25-30%).
- **Alginate**: 5.12 to 16.34 % DW (43.05 to 65.78% of total sugars).
- **M/G ratio** ranging between 2.41 and 3.06.

Analysis of FCSPs – Yield of extraction

- **Enzyme-assisted extraction (cellulases + alginate lyase)**



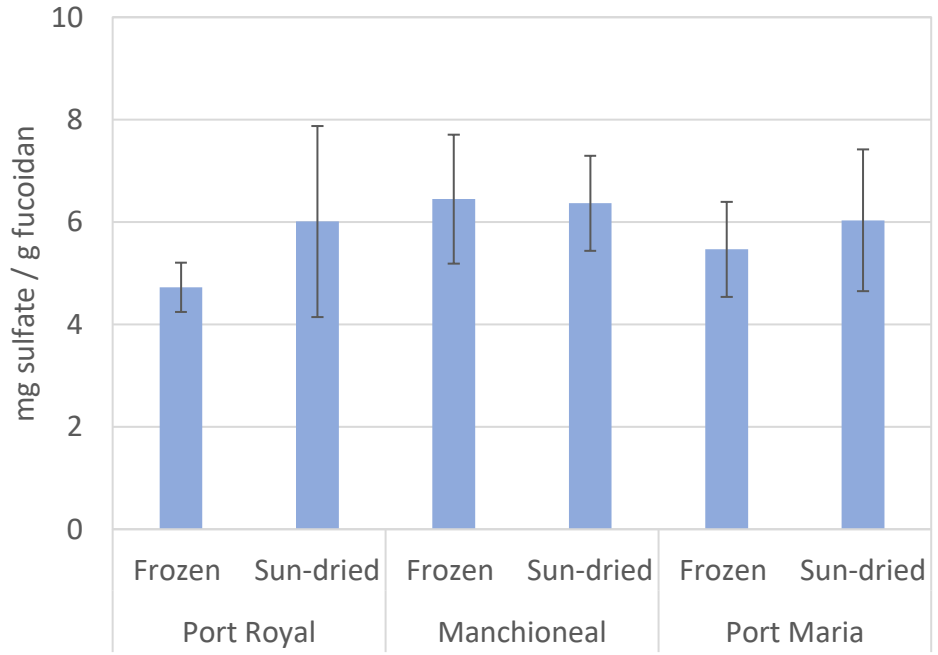
- **Acid extraction (0.1 N HCl)**



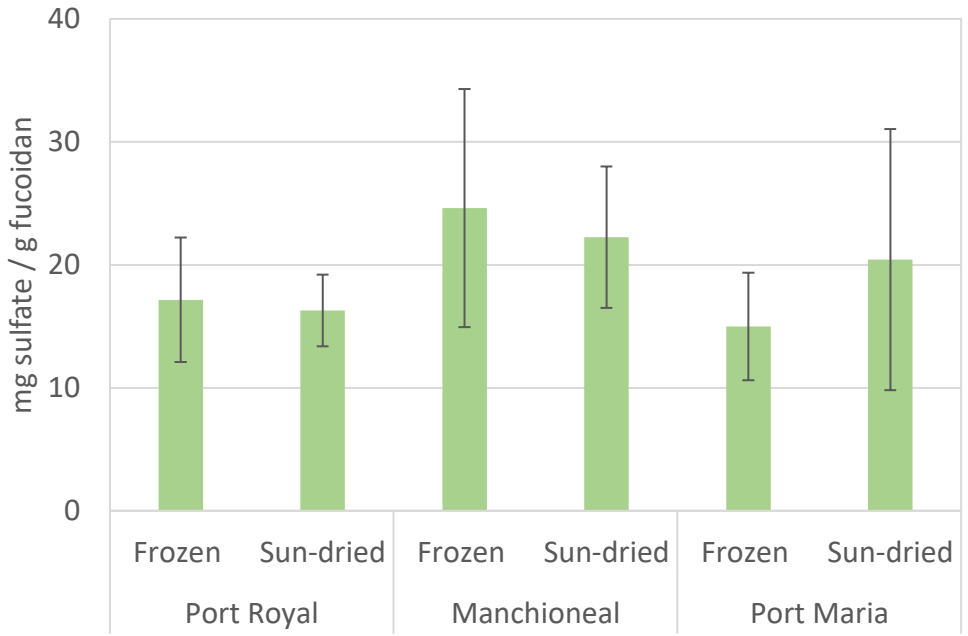
- 5-10 times more FCSPs extracted by the enzyme-assisted protocol.
- More FCSPs extracted from the sun-dried samples (except acid extraction Manchioneal samples).

Analysis of FCSPs – Level of sulfation

- **Enzyme-assisted extraction (cellulases + alginate lyase)**



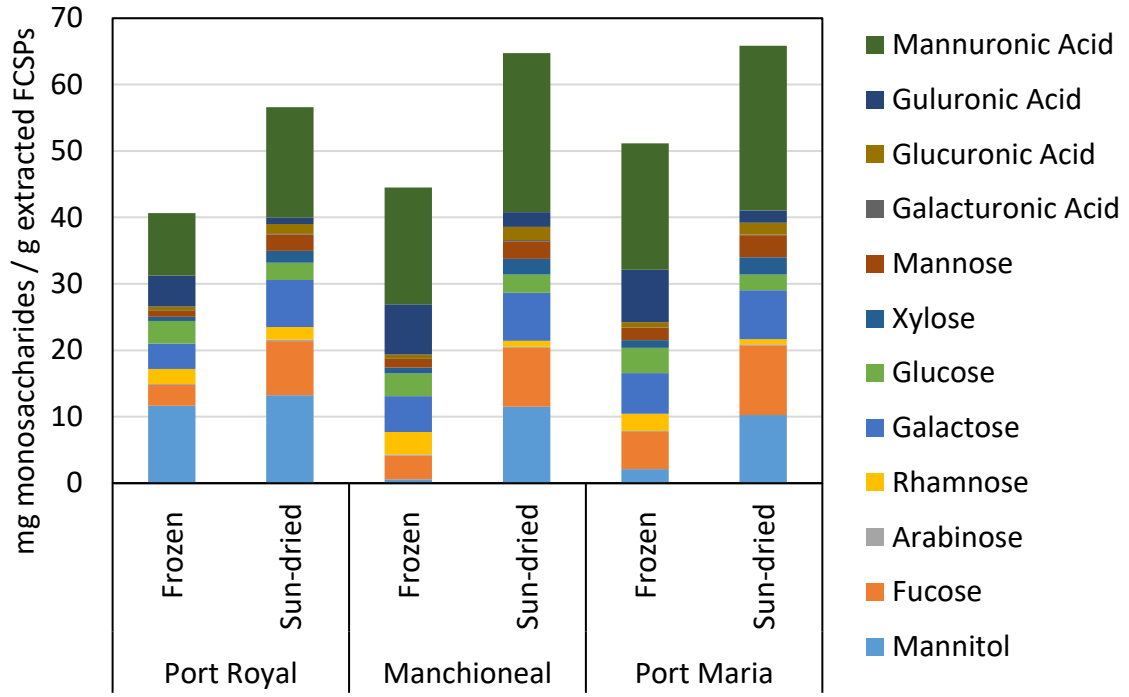
- **Acid extraction (0.1 N HCl)**



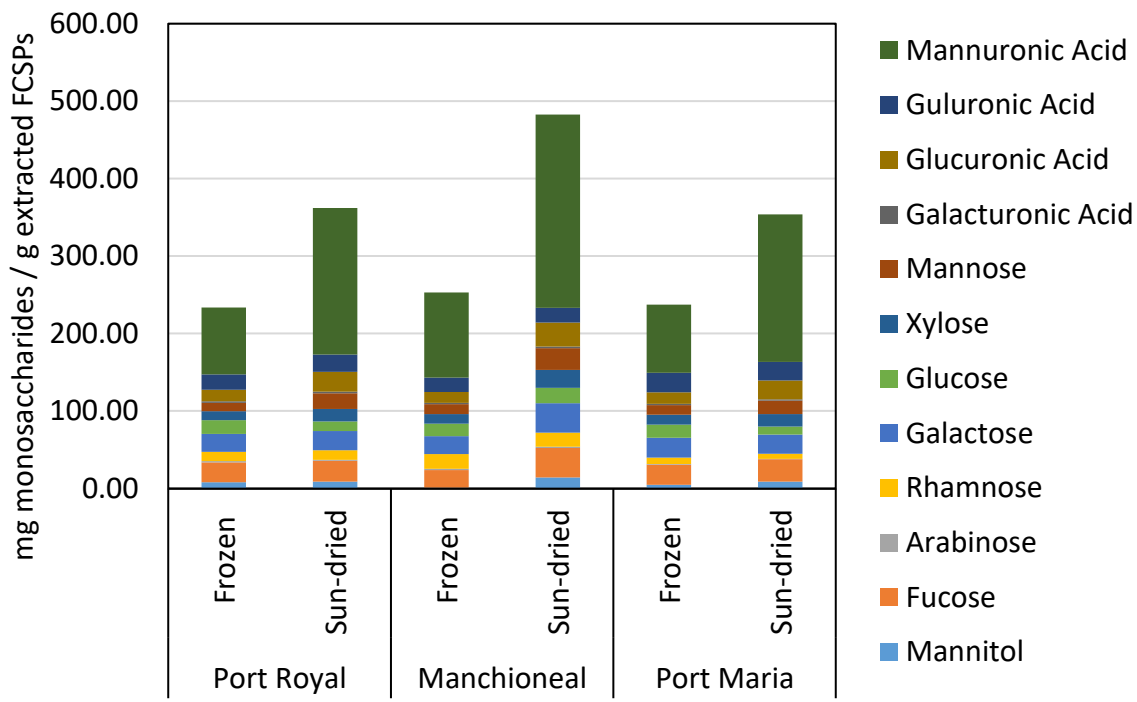
- Sulfation is important for bioactivities of FCSPs
- 3-5 times more sulfate in the FCSPs obtained by acid extraction.
- No significant differences in sulfate content between storage conditions and sample locations.

Analysis of FCSPs – Monosaccharide composition

- **Enzyme-assisted extraction (cellulases + alginate lyase)**



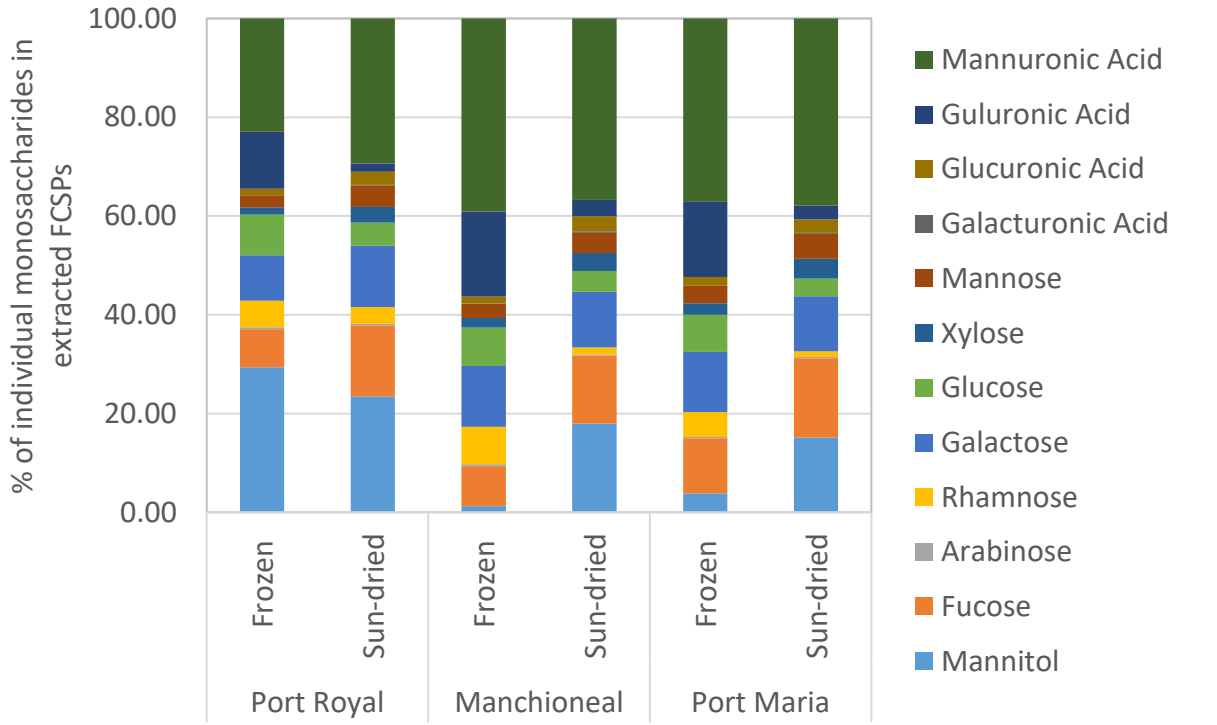
- **Acid extraction (0.1 N HCl)**



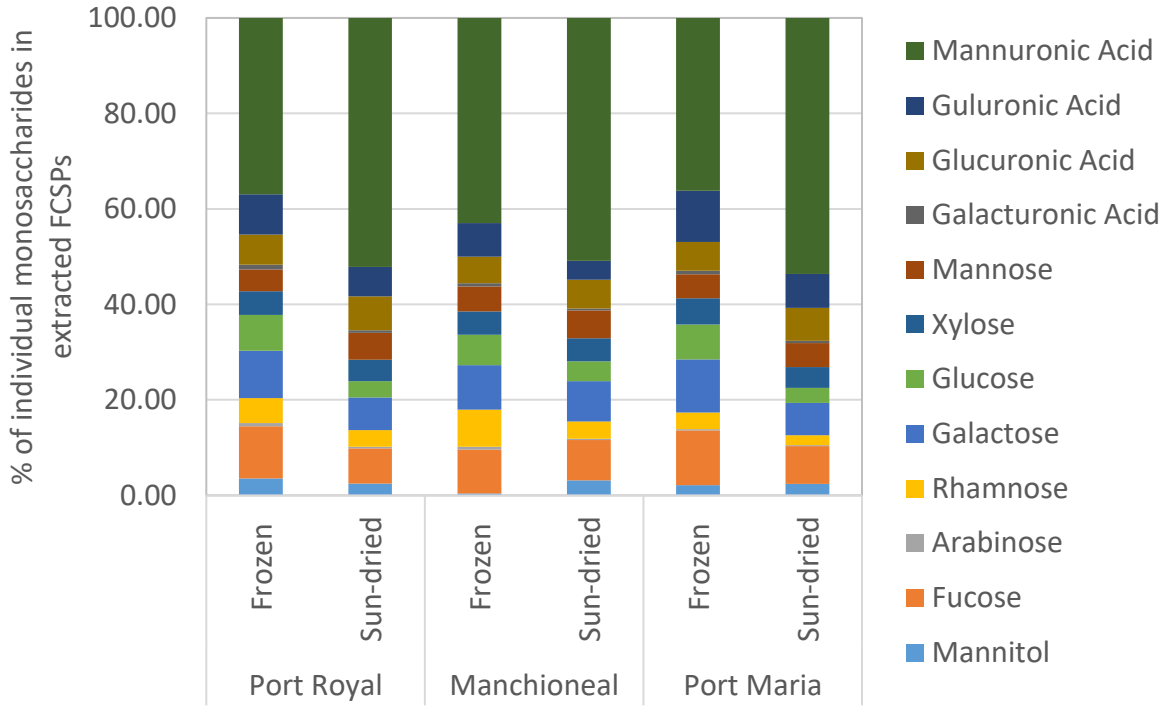
- Higher content of monosaccharides/uronic acids in FCSPs after acid extraction (234-483 mg/g compared to 40-66).
- Higher monosaccharide/uronic acid quantities in FCSPs from sun-dried samples for both types of extraction

Analysis of FCSPs – Monosaccharide composition

- **Enzyme-assisted extraction (cellulases + alginate lyase)**



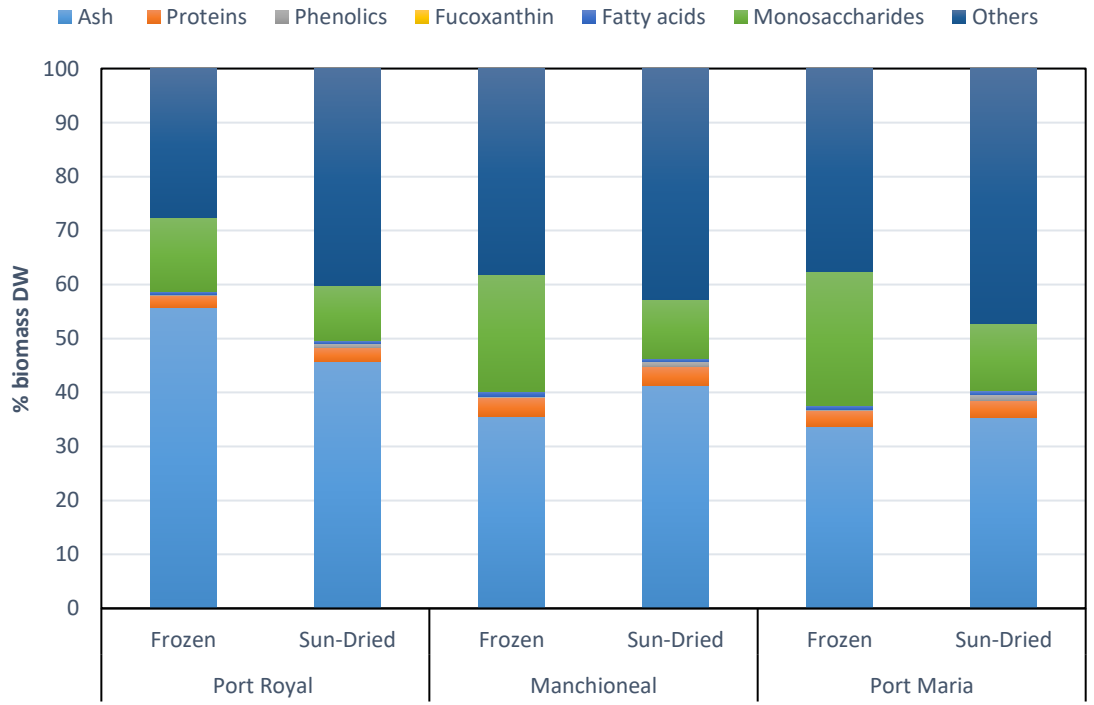
- **Acid extraction (0.1 N HCl)**



- Higher % of **fucose** after enzyme-assisted extraction, notably in sun-dried samples.
- Higher % of **rhamnose** in frozen compared to sun-dried samples after both types of extraction.
- High % of **alginate** (mannuronic and guluronic acid) in extracted FCSPs.
- Influence of extraction methods on structure and quality of the FCSPs.

Sample processing and biomass biochemical composition

- Cheap (sun) compared to expensive (freeze) drying techniques influence the biochemical composition of biomass.
- Sun-drying increased the proportion of phenolic compounds, but had a deleterious impact on fucoxanthin content and on the total monosaccharide content, except for mannitol.
- Limited variations were observed in ash, protein (not shown), and fatty acid content.
- More FCSPs extracted in sun-dried samples, and effect on FCSPs composition depends on their extraction method.



Sample processing and biomass biochemical composition

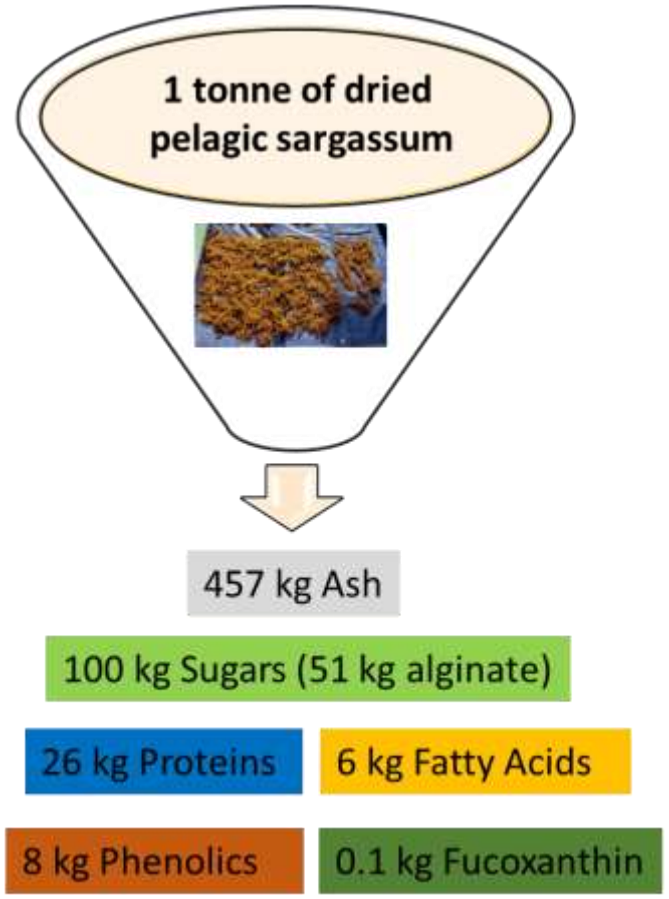
- Important parameters for the storage and transport of the pelagic sargassum biomass in the context of its valorisation.

- What is next:

-Compare frozen with shade-dried samples.

-Comparison of biochemical and elemental composition across a full season.

-On-going analysis of samples harvested in Port-Royal monthly from May to October 2021.



Port-Royal sun-dried samples

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